Naval Facilities Engineering Command
200 Stovall Street
Alexandria, Virginia 22332-2300

INSPECTION & CERTIFICATION OF BOILERS & UNFIRED PRESSURE VESSELS

NAVFAC MO-324

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FOREWARD

Boilers and unfired pressure vessels represent a major capital investment to the Navy. In addition, a substantial amount of resources are necessary every year for their operation and maintenance. Inspection of the equipment is necessary to insure the safety of personnel and to safeguard the Navy's investment in the equipment.

This manual provides guidance and criteria for the inspection of Navy shore establishment boilers and unfired pressure vessels. For maximum benefit, this manual should be used in conjunction with the American Society of Mechanical Engineer's (ASME) Boiler and Pressure Vessel Code and American National Standards Institute (ANSI)/NB-23 National Board Inspection Code. In general the manual establishes standards for the inspection of boilers and pressure vessels. Specific guidance is provided in areas where there are no industry standards or where industry standards are unclear. In case of a conflict, this manual should be followed. The manual is directed toward those persons who operate, maintain and inspect boilers and untired pressure vessels, whether directly or in a supervisory capacity.

Additional information or suggestions that will improve this manual are invited and should be submitted through appropriate channels to the commander, Naval Facilities Engineering Command, (Attention Code 165), 200 Stovall Street, Alexandria, VA 22332-2300.

This publication cancels and supersedes MO-324, Inspection & Certification of Boilers& Unfired Pressure Vessels, of April 1990. It has been reviewed in accordance with the Secretary of the Navy Instruction 5600.16A and is certified as an official publication of the Naval Facilities Engineering Command.

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Assistant Commander for
Public Works Centers and Departments

ABSTRACT

This manual provides policy and guidance for inspection and testing of boilers and unfired pressure vessels at Navy shore installations. It is provided to insure the safety of personnel and property. Direction is given to those persons responsible for the equipment and its inspection.

The manual has eleven chapters. The first three chapters establish the scope of the inspection program by delineating the responsibilities for inspecting equipment listing equipment exempted from the program, defining the qualifications required for inspectors, and providing inspection frequencies. Chapters four, five, six and seven provide guidance in regard to the procedures and tests used during inspections. Chapter eight contains guidelines for repairing the equipment, whether by government or private contractor. Chapter nine establishes criteria for issuing inspection certificates. Chapters ten and eleven provide information for calculating a pressure vessel's maximum allowable working pressure and for accident reporting respectively.

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Document all change page replacements, and pen and ink alterations posted ill this manual.

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CHAPTER 1. INTRODUCTION

1.1 PURPOSE. This manual covers the procedures necessary to determine the material condition of boilers and unfired pressure vessels to ensure their continued safe and reliable operation. The procedures also require determination of combustion efficiency and proper operation of boilers, boiler auxiliaries, and controls. Exceptions to these requirements will not be made without the formal concurrence of the Naval Facilities Engineering Command's (NAVFACENGCOM) Boiler Inspection Certification Board. The authority for these requirements is a Chief of Naval Operations letter dated 22 October 1970, Inspections of Boilers, Unfired Pressure Vessels, Elevators, Dumbwaiters and Escalators. The frequency of inspection and testing, the various items or components to be inspected or tested, and the forms to be used are specified in this manual.

1.2 RESPONSIBILITY The Commanding Officers of the cognizant activities ensure that the boilers and unfired pressure vessels installed at their facilities and covered by this manual are certified as specified. Inspection and testing of boilers and unfired pressure vessels shall be made by a boiler inspector certified by NAVFACENGCOM and/or licensed by the cognizant NAVFACENGCOM Engineering Field Division (EFD). This inspector will be on the cognizant activity's rolls, except:

- Where inspection responsibility has been assigned to the Commanding Officer of a Public Works Center.
- Where commanding officers of major or lead activities are responsible for performing the maintenance of public works and public utilities at adjacent activities.
- Where it may be impractical to employ qualified personnel for such inspections because of the limited workload. In such situation assistance in obtaining inspection services shall be requested from the appropriate EFD Commander/Commanding Officer. The EFD Commander/Commanding Officer shall arrange for the performance of those inspection services by an EFD inspector or an activity inspector located near the requesting activity, and which has qualified personnel, or by contract. When assistance is required by the EFD, such assistance will be rendered on a reimbursable basis. The requesting activity is responsible for providing the funds to accomplish the inspections.

1.3 APPLICABILITY. This manual is applicable to all heating and power boilers and unfired pressure vessels owned or leased by the Naval Shore Establishment including portable boiLers and portable unfired pressure vessels, liquid propane gas (LPG) storage tanks and Mobile Utilities Support Equipment (MUSE) boilers. Gas storage flasks, volume tanks, fire water tanks, and filters with a cross sectional internal dimension in excess of 3 inches are covered by this manual. The following equipment is not covered by this manual:

- Cylinders including DOT flasks, for shipment of compressed or liquefied gases. (DLA Regulation No. 4145.25, Storage and Handling of Compressed Gases and Liquids in Cylinders, and of Cylinders of 16 Jan 90 governs.)
- Air tanks for air brakes on vehicles.
- Unfired pressure vessels operating at an internal or external pressure not exceeding 15 pounds per square inch gage (psig) with no limitation on size.
- Unfired pressure vessels having a volume of less than 5 cubic feet and design pressure less than 250 psig or volume of less than 1.5 cubic feet and a design pressure less than 600 psig.
- Unfired pressure vessels containing only water under pressure at ambient temperature for domestic or industrial process supply purposes. Those containing air, the compression of which serves only as a cushion, must be inspected if pressures exceed those specified above.
- Unfired pressure vessels used as refrigerant receivers for refrigerating and air conditioning equipment.
- Coil type steam vapor cleaners unless requested by the activity.
- Unit heaters (gas, electric, or steam).
- Boilers and direct fired and domestic water heaters under 400,000 BTUs/hr input capacity unless requested by the activity.
- Residential and commercial warm air furnaces.
- Fire extinguishers.
- Shore based hyperbaric facility pressure vessels used for manned operations or for testing animals or equipment.

- Shore based hyperbaric facility pressure vessels used for manned operations or for testing animals or equipment.

1.4 LEASED BOILER Leased boilers shall be inspected by a contractor provided boiler inspector meeting the requirements of para. 2.2. The EFD/CO reserves the right to have these boilers inspected by a NAVFACENGCOM (EFD) inspector.

1.5 APPLICABLE CODES. The latest version of the following codes are applicable in the inspection and testing of boilers and pressure vessels.

- ASME Boiler and Pressure Vessel Code. Published by the American Society of Mechanical Engineers, New York, NY.
- National Board Inspection Code. Published by the National Board of Boiler and Pressure Vessel Inspection, Columbus, Ohio.
- National Fire Codes. Published by the National Fire Protection Association, Quincy, MA.
- ANSI/ASME CSD-1 Controls and Safety Devices for Automatically Fired Boilers. Published by the American Society of Mechanical Engineers, New York, N.Y.

This manual governs when a conflict occurs between the manual and the codes.

CHAPTER 2. INSPECTOR QUALIFICATIONS, CERTIFICATIONS AND LICENSES

2.1 NAVY EMPLOYEES. Navy employees who perform the inspections, witness the tests, prepare the reports, and issue the certifications described in this manual shall satisfy the following two condition

- Possess a valid NAVFACENGCOM Certificate of Competency.
- Possess a current license issued by the geographic EPD.

2.1.1 Qualifications for Certification. Candidates for the Certificate of Competency shall be qualified as follow

a. The candidate inspector shall have education and experience:

- from an accredited school a degree in mechanical engineering plus one year of experience in design, construction, operation or inspection of high pressure boilers and pressure vessels. Accredited school is defined as an engineering school accredited by the Accreditation Board for Engineering Technology (ABET).

or

- from an accredited school, a degree in a branch of engineering other than mechanical engineering plus two years of experience in design, construction, operation, or inspection of high pressure boilers and pressure vessels;

or

- a high school education or the equivalent plus three years of experience in one of the following categories:

(1) in high pressure boiler and pressure vessel construction or repair.

(2) in charge of high pressure boiler and pressure vessel operation.

(3) in the inspection of high pressure boilers and pressure vessels.

b. Job Requirement The inspection and certification of at least 10 boilers and/or unfired pressure vessels per year is part of the duties of the present or future position.

2.1.2 Certification Procedures. The activity shall recommend qualified candidates for certification to the NAVFACENGCOM Boiler Inspection Certification Board via the EFD. The letter of recommendation shall include:

- Current Position.
- Occupational record.
- Educational background.
- Supervisor's recommendation.
- Proposed inspection workload. Minimum workload is the inspection of 10 boilers and/or unfired pressure vessels per year as specified by 2.1.l.b.
- Evidence of successful completion of the National Board of Boiler Inspectors (NBBI) qualification examination.

2.13 Inspector Certification Test. The qualification examination tests the ability of the candidate to understand the ASME boiler and pressure vessel code. Candidates may wish to attend one of the commercially available boiler inspector preparatory schools. When requested by the EFD, the board will arrange the formal testing of qualified EFD and activity candidates by members of the NBBI. To ensure scheduling the candidate for the NBBI examination, the information requested must be received at the NBBI prior to the date of the examination.

2.13.1 Employment Only full time employees of the Navy will be certified. Gaps in employment do not effect certification, however, neither personnel not currently employed by the Navy nor part time employees will be permitted to perform inspections..

2.1.4 Qualifications for EFD licensing. EFDs shall license Navy employed inspectors every two years, providing they satisfy the following five conditions:

- Possess a valid NAVFACENGCOM Certificate of Competency.
- Are full-time employees of the Navy.
- Maintain an inspection workload of at least 10 boilers and/or unfired pressure vessels per year.
- Conduct inspections in accordance with this manual.
- Are not employed in a capacity that constitutes a conflict of interest, as defined in paragraph 2.1.5.

2.1.5 Conflict of Interest. The EFD shall not license inspectors who:

- Operate or maintain any of the boilers to be inspected.
- Supervise the operation or maintenance of such boilers.
- Report directly to the boiler operations supervisor in any capacity of their employmet.

2.1.6 Inspector Support Before licensing inspectors the EFD shall seek the following assurances from the employing activity

- Current applicable codes, equipment and tools are maintained and available to the inspector.
- Records of inspections are maintained and available for examination by the EFD's Senior Inspector or boiler inspection program manager.
- The inspector will be available to other Activities for inspection on a reimbursable basis, depending on workload.

2.2 CONTRACT EMPLOYEES. All persons employed by contractors which perform the inspections, witness the tests, prepare the reports, and issue the certificates described in this manual shall as a minimum possess a Certificate of Competency or the equivalent issued by any political subdivision (such as state, province, territory, county, or city) of the United States or Canada that is a member of the NBBI except for contractors performing inspections outside the U.S. The Pacific Division and Atlantic Division of the Naval Facilities Engineering Command shall set the requirements for contractors performing inspections outside the U.S.

2.3 CREDENTIAL REQUIREMENTS. Inspection certificates, NAVFACENGCOM Form 9-11014/32 (3-67), for boilers and unfired pressure vessels may only be issued by inspectors who meet one of the two category requirements in Table 2-1.

TABLE 2-1
Credentials Required

CATEGORY	CREDENTIALS REQUIRED		
	STATE CERT. OF COMPETENCY	NAVFACENGCOM CERT. OF COMPETENCY	EFD LICENSE/ AUTHORIZATION TO INSPECT
1. Contract X Inspector			x
2. Civ. Serv. Inspector		x	x

Notes for Table 2-1:

1. A NAVFACENGCOM Certificate of Competency issued after September 1983 requires passing the NBBI Exam. A NAVFACENGCOM Certificate of Competency issued before September 1983 required passing a Navy Exam. In addition authorization to issue NAVFACENGCOM Inspection Certificates requires an EFD license.

2. A contract inspector may not be employed by a contractor utilized to operate or maintain the equipment to be certified.

3. In addition to the State Certificate of Competency, contract inspectors must have a written Authorization to Inspect from the geographical NAVFACENGCOM EFD. An official letter from a member jurisdiction of the NBBI stating that the individual has passed the NBBI examination can be considered equivalent to the State Certificate of Competency.

2.4 QUALITY ASSURANCE FOR INSPECTIONS. Appendix A shows the NAVFAC Boiler and Unfired Pressure Vessel Inspection Program Quality Assurance Organization. This organization provides a method of monitoring the performance of EFD, activity and contract inspections. The key element of the organization is the Senior EFD Inspector. The duties and qualifications of the Senior EFD Inspector are outlined in Appendix B.

2.5 GUIDELINES FOR INSPECTION CONTRACTS. The inspection of boilers and pressure vessels is highly specialized work requiring qualified personnel and in many cases specialized testing equipment. The contracting officer is responsible for ensuring the quality of inspections performed by companies awarded Navy inspection contracts.

2.5.1 Contractor Abilities. The ability of contractors and their inspectors to provide adequate inspections can be highly variable. The NBBI commissions inspectors of jurisdictions which have adopted and administer one or more sections of the ASME Boiler and Pressure Vessel Code as a legal requirement and has a representative serving as a member of the ASME Conference Committee; or to an insurance company which is licensed by a state of the U.S. to write boiler and pressure vessel insurance. An Authorized Inspection Agency is not working within the NBBI charter when performing inspections on a federal reservation because a state's jurisdiction does not encompass military reservations and the government does not insure its equipment. Furthermore, Authorized Inspection Agencies usually do not qualify as small businesses.

2.5.2 Companies other than Authorized Inspection Agencies. Quality assurance for such companies may not be structured according to a standard recognized by the NBBI or may even be non-existent. Contracting Officers should ensure adequate inspections by requiring qualifications of the contractor before awarding the contract. These assurances should as a minimum include requiring the contractor to supply inspectors with the credential requirements of paragraph 2.3.

2.5.3 Assistance. The EFD of the NAVFACENGCOM reduce the risk associated with inspection contracts by administering the contracts for activities. When an activity elects to administer its own inspection contract, the EFD provides assistance to the contracting officer by reviewing the contract requirements and determining the suitability of a company to perform inspections. The EFDs provide this service on a reimbursable basis. The EFDs also provide quality control by monitoring the performance of contractors and their inspectors. Upon satisfactory review the EFD can issue Authorizations to Inspect to the fires qualifying inspectors for the term of the contract. The Authorization to Inspect identies the ability of the inspector to perform the work satisfactorily and authorizes the inspector to sign the Inspection Report-Boilers

and Pressure Vessels and issue the Inspection Certificate NAVFAC Form 9-11014/32 (3-67).

2.5.4 Activity Administered Contracts. When the activity contracting officer elects to administer the contracts, the contracting officer should require the contractors to provide enough information to determine positively that the firm has qualified inspectors and has the capability to do the required work. The scope of work for the inspection contract should include the number, function, type (such as boiler or pressure vessel), construction (such as the American Society of Mechanical Engineers' (ASME) Boiler and Pressure Vessel Code or military specification), capacity and pressure rating of each vessel. In addition, the contract should require that the contractor have:

- Inspectors with credentials complying with paragraphs 2.1.l.b, 2.2 and 2.3.
- An inspection work history similar to that required for the proposed work.

2.6 CREDENTIAL REQUIREMENTS. Inspection certificates, NAVFACENGCOM Form 9-11014/32 (3-67), for boilers and unfired pressure vessels may only be issued by inspectors who meet one of the two category requirements in Table 2-1.

CHAPTER 3. INSPECTION AND TEST FREQUENCIES

3.1 BOILERS. Inspection and test frequencies for boilers are shown in Table 3-1.

TABLE 3-1

Inspection and Test Frequencies - Boilers

Item	Internal Inspection	External Insp & Operational Tests	Hydrostatic Tests
Boilers - Wet or dry lay-up	At least annually. At resumption of active service.	At least annually. At resumption of active service.	Tightness test at resumption of active service.
Boilers - Heating and LTW	At least annually. After any repair or alteration of pressure parts.	At least annually. After any alteration or modification to boilers control equipment or auxiliaries.	Strength test at least once every 6 years. Tightness test all other years. Strength test after repair or alteration of pressure parts. Additional times at the discretion of the inspector.
LTW boilers with Inputs < 5MBTUH	At least once every three years.		
Boilers - Power, High-pressure, HTW, MUSE	At least annually. After repair or alteration of pressure parts.	At least annually. After any alteration or modification to boilers, control equipment or auxiliaries	Strength test at least once every 3 years. Tightness test all other years. Strength test after repair or alteration. Additional times at the discretion of the inspector.

TABLE 3-1 (Continued)
Inspection and Test Frequencies - Boilers

Item	Internal Inspection	External Insp & Operational Tests	Hydrostatic Tests
Domestic Hot Water Heaters	Inapplicable	At least annually	Discretion of Inspector Note: Glass Lined Vessels not to exceed Maximum Allowable Working Pressure (MAWP)

Notes for Table 3-1:

1. Additionally, Mobile Utility Support Equipment (MUSE) boilers and other portable boilers shall be inspected externally and internally and certified each time they are relocated from one activity to another. MUSE steam coil type boilers are exempt from annual inspections while in dry or wet lay-up.

2. All manhole and handhole gaskets must be replaced after application of the strength test unless they are of the non-compressible steel type

3.2 UNFIRED PRESSURE VESSELS. Inspection and test frequencies for unfired pressure vessels shall be as shown in Table 3-2 Table 3-3, or Table 3-4, as applicable.

TABLE 3-2
Inspection and Test Frequencies - Unfired Pressure Vessels

Item	External/Operational Inspection	Internal Inspection	Hydrostatic Tests
Pressure Vessels &Heat exchangers (15 to 250 psig MAWP)	Every 2 years or more frequently as determined by procedures in the NBBI Code for vessels subject to corrosion. After any repairs or modifications. Inspection must include test and calibration of safety valves and pressure and temperature gages	Every 2 years or more frequently as determinedly procedures in the NBBI Code for vessels subject to corrosion. After any repairs or modifications. Inspection must include test and calibration of safety valves and pressure and temperature gages. For propane and other non-corrosive vessels Ultrasonic Testing maybe substituted for visual internal insp.	After repair or alteration of pressure parts. Additional times at the discretion of the inspector.
Pressure Vessels &Heat exchangers (251 up to 3000 psig MAWP)	Every 2 years or more frequently as determined by procedures in the MBBI Code for vessels subject to corrosion. After any repairs or modifications. Inspection must include test and calibration of safety valves and pressure and temperature gages.	Every 2 years or more frequently as determined by procedures in the NBBI Code for vessels subject to corrosion. After any repairs or modifications. Inspection must include test and calibration of safety valves and pressure and temperature gages. For propane and other non-corrosive vessels Ultrasonic Testing maybe substituted for visual internal insp.	Every 6 years of service. If inspection shows no sign of corrosion the test maybe deferred until the next inspection, but must be tested at least every 12 years. After any repair or alteration of pressure parts. Additional times at the discretion of the inspector.

Notes for Table 3-2:

1. Test frequencies and inspections maybe increased at the discretion of the inspector or owner if the UPV is subjected, by the nature of its service, to an accumulation of deposits or thermal or mechanical stresses that could affect the integrity of the vessel.

2. A hydrostatic pressure test not to exceed 1.5 times the MAWP for ASME Section VIII Div 1 vessels and 1.25 times the MAWP for ASME Section VIII Div 2 vessels may be substituted for the internal inspection.

3. If the tube bundle of the heat exchangers is a higher pressure than the shell both sides of the heat exchanger shall be hydrostatically tested.

TABLE 3-3
Inspection and Test Frequencies - Unfired Pressure Vessels (Special Cases)

Item	External/Operational Inspection	Internal Inspection	Hydrostatic Tests
systems operating at pressures of 3000 psig MAWP and greater	The frequency and procedures for inspection of ASME Code and MILSPEC vessels is the same as the frequency and procedures required for hyperbaric facility support pressure vessels. Activities may elect to prepare and inspect MILSPEC vessels using NAVSEASYSCOM boiler inspectors according to Naval Ship's Technical Manual S9086-SY-STM-010, Chapter 551, Compressed Air Plants. To reduce duplication of effort, no NAVFACENGCOM certificate is necessary as long as the vessel has a valid NAVSEASYSCOM safety certificate. A pressure vessel which is neither MILSPEC or ASME Code may only be certified when design drawings and engineering calculations from the manufacturer arc available to the inspector to positively determine whether the vessels is safe to operate. The inspector may ask for proof of the manufacturer's quality control procedures and teats prior to issuing a certificate of safety.		
Hyperbaric Facility support Pressure Vessels see Note 1.	Every two years of service. Inspection must include test and calibration of safety valves & pressure gages After any repair or alteration.	Every two years of service. Inspection must include test and calibration of Safety valves & pressure gages. After any repair or alteration.	Every 6 years of service. If inspection shows no sign of corrosion, the test may be deferred until the next insp-ection, but must be tested at least every 12 years. After arty repair or alteration of pressure parts. Additional times at the discretion of the inspector. In accordance with paragraph 5.4.3 and 5.4.5.

Notes for Table 3-3:

1. For hyperbaric facility support vessels the test pressure shall be in accordance with the Nationally accepted standard to which the pressure vessel was constructed. For example, ASME Section VIII Division 1 or 2.

2. A visual internal inspection for hyperbaric facility support vessels is not required every two years provided the vessel (or vessel bank) successfully passes a gas analysis with acceptable oil mist plus particulate matter concentration equal to or less than 5 milligrams per cubic meter and dew-point equal to or colder than -40 degrees fahrenheit; and an ultrasonic thickness measurement check in accordance with paragraph 5.4.2. The maximum acceptable interval between visual inspections is 12 years.

TABLE 3-4
Inspection and Test Frequencies - Deaerators

Item	External/Operational Inspection	Internal Inspection	Hydrostatic Tests
Deaerators	Every 10 years. After any repairs or modifications Inspection must include test and calibration of pressure and temperature gages.	Every 10 years.. After any repairs or modifications. Inspection must include test and calibration of pressure and temperature gages.	Tightness test after internal inspection. Strength test after repairs. Other times at the discretion of the. inspector.

Notes for Table 3-4:

1. If inspection reveals that repairs must be made to pressure parts, then the inspection frequency will be increased to every six years. No certificate of safety will be issued until after the repairs are accomplished. Inspection may again be increased to a 10 year cycle, if at least two subsequent inspections reveal no further evidence of cracking or excessive corrosion.

2 In addition to the safety inspection the operators of the vessel should periodically examine and test the deaerators for proper operation. Improperly operating deaerators result in excessive corrosion and cracking. The key to satisfactory operation is proper water treatment.

3. Scheduling of deaerator inspection at many facilities requires scheduled downtime for many heating and power

plants. The activity should prepare to hire a a company specializing in deaerator evaluations to determine if the vessel is repairable if cracking or excessive corrosion is found during the visual inspection. Options to lease deaerators prior to the in-spection should be considered. Assistance maybe obtained from the geographic Engineering Field Division of the Naval Facilities Engineering Command.

CHAPTER 4. BOXIER INSPECTIONS

4.1 GUIDANCE. The activity operating and maintaining the boiler shall provide all material and labor necessary to prepare the boilers for inspection in accordance with the NBBI Code. The activity shall assist the inspector as required during the inspections. Exception to this policy occurs when the operation and maintenance of a boiler is under the cognizance of a contractor. In which ease, the contractor shall be responsible for providing material, labor and assistance. Inspections of boilers located on naval bases in foreign countries must comply with MO-324 under the constraints of the Status Force Agreement in effect. Inspectors should not compromise safety issues but should exercise restraint when interpreting the fine points of the ASME Code. Further guidance on foreign inspections should be obtained from the cognizant geographic EFD of the NAVFACENGCOM serving the activity.

4.2 EXTERNAL INSPECTIONS OF BOILERS. External inspections of boilers shall be made in accordance with Chapter II, Section 1-200, External Inspection of Boilers of the National Board Inspection Code. The testing of safety devices shall occur as part of the external inspection. Final testing of the safety valves of power boilers shall be on the boiler to which the valve will be mounted. The operational tests and observations of CHAPTER 7 are considered to be part of the external inspection.

4.3 INTERNAL INSPECTION OF BOILERS. Internal inspections of boilers shall be made in accordance with Chapter II, Section 1-300, Internal Inspection of Boilers- Power and Heat&of the National Board Inspection Code. Boiler inspectors shall have the authority to order that boiler metal samples and/or ultrasonic tests be taken for their examination to ascertain the actual condition of the pressure parts.

4.4 BOILERS IN WET OR DRY LAY-UP. In addition to the external and internal inspections required above, the lay-up procedures being used shall be reviewed to ensure that they conform to the requirements of Appendix C.

CHAPTER 5. UNFIRED PRESSURE VESSEL INSPECTIONS

5.1 GUIDANCE. The activity operating and maintaining the pressure vessel shall provide all material and labor necessary to prepare the unfired pressure vessels for inspection in accordance with the NBBI Code. The activity shall assist the inspector as required during the inspections. Exception to this policy occurs when the operation and maintenance of the pressure vessel is under the cognizance of a contractor. In which case, the contractor shall be responsible for providing material, labor and assistance. Inspections of pressure vessels located on naval bases in foreign countries must comply with MO-324 under the constraints of the Status Force Agreement in effect. Inspectors should not compromise safety issues but should exercise restraint when interpreting the fine points of the ASME Code. Further guidance on foreign inspections should be obtained from the cognizant geographic EFD of the NAVFACENGCOM serving the activity.

5.2 EXTERNAL INSPECTIONS OF PRESSURE VESSELS. External inspections of unfired pressure vessels shall be made in accordance with Chapter II, Section 1-400, Inspection of Pressure Vessels, of the National Board Inspection Code.

53 INTERNAL INSPECTIONS OF PRESSURE VESSELS. Internal inspections of unfired pressure vessels shall be made in accordance with Chapter II, Section I-5(X), Internal Inspection of Pressure Vessels, of the National Inspection Code. Inspectors shall have the authority to order that metal samples and/or ultrasonic tests be taken for their examination to ascertain the actual condition of the vessel.

5.4 HYPERBARIC FACILITY SUPPORT PRESSURE VESSELS.

5.4.1 Internal & External Inspections. Vessels shall be examined in accordance with paragraphs 5.2 and 5.3. Internal surfaces shall be viewed using a boroscope, if necessary, supplied by the activity or by another acceptable method. Areas of wear, corrosion, abuse and/or damage shall be recorded and attached to the inspection report.

5.42 Ultrasonic Examination Vessels shall be subjected to an ultrasonic thickness measurement check. The checks shall be made by the activity and observed by the inspector. The checks shall be made at the point of tangency between the cylinder and the end heads. The measurements shall be taken at two inch intervals around the circumference

of the vessel. Measurement shall be taken on a line along the head from the point of tangency, across the end of the head to the far point of tangency; measurements shall be taken along a similar line at right angles to the first at the end of the head. Lines of measurement shall be taken at each end of the vessel. The lines shall be so arranged that the vessel low point, where water may collect and corrosion may form, is measured. Measurements shall be taken every two years. Ultrasonic measurement points for vessel configurations other than spherical or cylindrical shall be approved by the inspector. The lines and points of measurement shall be identical at each inspection. Records of the measurements shall be retained by the activity. The vessel shall not be certified if the measured thickness is less than that prescribed by the standard by which it was constructed. For example: ASME Section VIII, Division 1, ASME Section VIII, Division 2, or Military Specification MIL-F-22606B (SHIPS).

5.43 Examination of High Stress Areas. A liquid dye-penetrant or magnetic particle examination or other method authorized by the NAVFACENGCOM System Certification Authority shall be performed on all areas of high stress concentration such as nozzles, welds, plugs, threads, etc. before each strength test. The purpose of this examination is to identify any defects which have occurred as a result of high or cyclic stresses.

5.4.4 Variations. Requests for variations in the inspection and testing procedures for hyperbaric facility support pressure vessels should be addressed to the NAVFACENGCOM System Certification Board with a copy to the cognizant geographic Engineering Field Division of the Naval Facilities Engineering Command. Appendix A depicts the relative position of the System Certification Board in the NAVFACENGCOM boiler & pressure vessel inspection quality assurance organization.

5.5 DEAERATORS. The purpose of a deaerating heater (deaerator) is to remove non-condensable gases and dissolved oxygen from the feedwater. A properly operating deaerator will have no more than 10 ppb O_2 in the outlet water. Deaerators are subject to thermal cycling and corrosion. Proper operation of deaerators is extremely important because of their critical function in protecting the boiler system from corrosion. Catastrophic failure of deaerators is usually attributable to cracks forming longitudinally and transversely to the heat affected zones of the welds. Deaerators are potentially a great danger because of their loca-

tion at the top of the heating or power plant. To ensure deaerators provide safe reliable service, they require periodic visual inspections of their internal and external surfaces. If visual inspection reveals cracks, then a company specializing in deaerator inspection must perform ultrasonic examination of the entire vessel and wet fluorescent magnetic particle examinations of the heat affected zones of the welds prior to certification to determine if continued operation of the vessel is safe. Repairs must be subjected to post-weld heat treatment and hydrostatic testing prior to certification.

CHAPTER 6. PRESSURE TESTS

6.1 HYDROSTATIC TESTS. Hydrostatic tests shall be made in accordance with Chapter II, paragraph 1-303.23, Hydrostatic Test, for boilers and Chapter **II,** paragraph 1-502.10, Pressure Test, for unfired pressure vessels of the National Board Inspection Code and the paragraphs below.

6.1.1 Strength Test Pressure Strength tests shall be based on the maximum allowable working pressure of the boiler or the vessel as marked or as recalculated as a result of previous tests. All boilers and unfired pressure vessels which are covered by ASME Section I or Section VIII Div 1 subjected to internal pressure shall be tested hydrostatically at a pressure of l-1/2 times the highest safety valve popping pressure or l-1/2 times the MAWP, whichever is less. Unfired pressure vessels constructed by the standards of ASME Section VIII Div 2 subjected to internal pressure shall be tested hydrostatically at a pressure of l-1/4 times the highest safety valve popping pressure or l-1/4 times the MAWP, whichever is less. Exceptions follow

- Vessels that are not capable of supporting the weight of liquids (see Chapter 10, MAWP and paragraph 6.2, Pneumatic Tests).
- Vessels not readily dried that are to be used in services where traces of the testing liquid cannot be tolerated (see paragraph 6.2, Pneumatic Tests).
- The test pressure for enameled vessels shall be at least equal to, but need not exceed, the maximum allowable working pressure marked on the vessel.
- The test pressure for glass lined vessels shall not exceed the maximum allowable working pressure.
- The test pressure for cast iron vessels shall be 2 times the design working pressure for design pressure greater than 30 psig and 2-1/2 times the design pressure but not to exceed 60 psi for design pressures under 30 psig.
- The test pressure for vessels and piping in high pressure air systems (3000 psig and over) shall be l-1/2 times the design pressure of the system.
- The test pressure for new boilers and new unfired pressure vessels shall be 1-1/2 times the maximum allowable working pressure. The test pressure for subsequent tests shall not

exceed 1-1/2 times the maximum allowable working pressure.

6.1.1.1 Vacuum Vessels. Single-wall vessels designed for a vacuum or partial vacuum only, and chambers of multi-chamber vessels designed for vacuum or partial vacuum only, need not be subjected to a hydrostatic test.

6.1.12 Special Combination Units. Special combination units shall be so tested that each pressure chamber (vessel) receives the required hydrostatic test without pressure in the others.

6.1.13 Hydrostatic Tests with Fluids other than Water. The test procedures for fluids other than water must be approved by the NAVFACENGCOM Boiler Inspection Certification Board.

6.1.2 Tightness Test Pressure. The tightness test pressure shall be above the normal operating pressure, but not exceed the lowest safety valve set pressure. Safety valves shall be blocked or gagged for this test.

6.13 Precautions.

- Direct connection of the boiler to the water system is prohibited where aback-flow preventer is not installed to prevent contamination of the potable water system.
- A power driven or hand pump shall be provided for application of the test pressure, if the boiler feed pump will not deliver the test pressure. The test pump shall be provided by the activity and operated and inspected to ensure that it is in proper working condition prior to connecting it to the boiler or the vessel.

6.1.4 Possible Deformation. If any indications of probable permanent deformation are observed, the test shall cease until the weak parts have been properly strengthened. If necessary repairs are not practicable, a new test, progressing up to 20 psi less than the pressure at which the proceeding test ceased shall be applied. If the testis successful, the new maximum allowable working pressure shall be two-thirds of the test pressure, and the safety valves shall be reset or replaced in accordance with the new maximum allowable working pressure.

6.1.5 Hold Pressure.

- For all boilers and heat exchangers, pressure shall not drop more than 10% withing 15 minutes. If pressure drop

exceeds 10%, leaks shall be repaired and test repeated. If pressure drop is within 10% and inspection does not reveal leaks in the pressure parts, it may be assumed that the leaks are through the isolation valves, manholes, and hand holes.

- For all unfired pressure vessels and hyperbaric facility support pressure vessels, the hold pressure shall drop no more than **1%** in one hour for vessels with design pressure greater than 500 psig and 5% in one hour for vessels with design pressure 500 psig or less.

6.1.6 Inspection Under Pressure. All joints and connections shall be inspected for leaks or other defects while the vessel is under pressure. The pressure held during this inspection need not necessarily be equal to hydrostatic test pressure, but shall be not less than two-thirds of hydrostatic test pressure.

6.1.7 Permanent Deformation. Where permanent deformation of the vessel shell or heads or of the boiler shell or drum has occurred, whether as a result of hydrostatic pressure tests or from normal operating pressures, repairs shall be made only after it has first been definitely determined that such repairs are practicable and economical. After approved repairs of this nature have been completed, the maximum allowable working pressure of the vessel or boiler shall be recalculated according to the requirements of Chapter 10. Prior to returning the vessel or boiler to service, a hydrostatic test, based on the recalculated maximum allowable working pressure, shall be made.

6.1.8 Gaskets. Manhole and handhole gaskets shall be replaced after performing the hydrostatic strength test unless a non-compressible metal gasket is used.

6.2 PNEUMATIC TESTS. A pneumatic test should be resorted to only in extreme cases when a hydrostatic testis not permissible. No pneumatic tests shall be performed without the written approval of the NAVFACENGCOM Boiler Inspection Certification Board. This approval can be requested by submitting a request in writing to NAVFACENGCOM via the geographic EFD along with the proposed pneumatic test procedures for each particular test. The pneumatic test pressure shall be 1.25 times the MAWP pressure for Division 1 vessels and 1.15 times the MAWP for Division 2 vessels. A pneumatic test may be used in lieu of the hydrostatic test prescribed in paragraph 6.1 of this chapter, with NAVFACENGCOM approval as follows:

- For vessels that are so designed and/or supported that they cannot safely be filled with water.
- For vessels not readily dried that are to be used in services where traces of the testing liquid cannot be tolerated and the parts of which have, where possible, been previously tested by hydrostatic test pressure.

63 PRESSURE TEST RESULTS.

63.1 Yielding During Test. If yielding occurs, and examination shows the vessel is in satisfactory condition the allowable working pressure shall be established as 50 percent of the pressure at yielding.

6.3.2 No Yielding During Test. If yielding does not occur, the pressure should be increased step by step until the required test pressure has been reached. Then the pressure shall be held for a sufficient time to permit inspection of the vessel for leakage or signs of failure.

6.3.3 Inspection Under pressure. If permanent deformation occurs, the vessel shall be replaced or repaired. If permanent deformation occurs in a vessel not constructed to the ASME Boiler and Pressure Vessel Code, the vessel shall be drilled and discarded.

CHAPTER 7. OPERATIONAL TESTS

7.1 GUIDANCE. Following internal inspection as part of the external inspection, the boiler or unfired pressure vessel shall be brought up to operating pressure and temperature. All automatically and manually operated control devices provided for controlling the operation and safety of the vessel, steam or water pressure, hot water temperature, combustion, and boiler water level shall be inspected and caused to function under operating conditions. All associated valves and piping, pressure and temperature indicating devices, metering and recording devices, and all boiler auxiliaries shall be inspected under operating conditions. Boilers firing oil or gas without fully automatic or semiautomatic controls must have an EFD waiver to be certified. All combustion controls attached to the boiler regardless of the fuel being fired must be in good working order or the inspection certificate shall be withheld Inspections and tests of boilers maybe made with the main steam or hot water distribution valves closed or open, as necessary, to fire the boiler and operate it under normal operating conditions. Testing the function of automatically or manually controlled devices and apparatus that may interfere with the distribution requirements should be done with the main steam or hot water distribution valves closed as applicable.

7.1.1 Purpose. The purpose of these additional inspections and tests is to allow the inspector to discover any inefficient or unsafe operation or maintenance of the vessel or of the boiler or its auxiliaries that may be evidenced under operating conditions.

7.1.2 Conditions to be Reported. All deficiencies requiring adjustment, repair, or replacement and all conditions indicating excessive operating and maintenance cost shall be reported Certificates shall be withheld until the deficiencies are corrected.

7.2 FIRING EQUIPMENT. The operation of all firing equipment including oil burners, gas burners, fuel injectors, fuel igniters, coal stokers, and feeders, burner safety controls and other such equipment provided to introduce fuel into the boiler furnace and to ignite the fuel, shall be inspected for any deficiency that maybe evidenced under operating conditions. All fuel leaks must be repaired before the certificate is issued.

7.3 CONTROLS. Inspect the operation of all controls directly associated with the operation and safety of the boiler for any defects

preventing proper operation. These controls include such items as unloading valves, high pressure cut-out devices, high temperature cut-out devices, low-pressure cut-in devices and burner safety controls. Inspect the operation of combustion controls, steam pressure controls water temperature controls, and feedwater controls. Make sure that the ability of the combustion control and steam pressure control to maintain proper steam pressure (or water temperature in high temperature water installations) and air-fuel ratio is demonstrated throughout the capacity range of the boiler and the load swings encountered in the operation of larger boilers. Air-fuel ratio shall be checked by the activity or the inspector by both CO_2 and O_2 measuring devices. CO shall also be checked. Check fully automatic boiler controls for the proper programming sequence and timing with respect to pre-purge, ignition, pilot proving flame proving, and post-purge periods. Check the operation of flame failure and combustion air failure devices to ensure that they properly shut off the supply of fuel; this should be done by simulating a flame failure (by manually shutting off the fuel or by other means) and by observing the operation of the controls, solenoid valves, diaphragm operated valves and so forth, which are to operate during a flame failure. The operation of automatic burner management systems shall comply with the National Fire Codes and/or ANSI/ASME CSD-1 in effect at the time of installation of the boiler. Inspect feedwater controls, and check the ability of the controls to maintain proper water level throughout the range of capacity with load swings. Check the operation of the low-water fuel cutoff and automatic water feeding devices by draining the float bowl, lowering the boiler water level and performing with necessary steps to cause these devices to function to ensure that they operate properly.

7.4 PIPING AND PIPING CONNECTIONS. While the boiler (or vessel) is operating, examine all steam and water pipes, including connections to the water columns and all associated piping for leaks, and if any are found, determine whether they are the result of excessive strains due to expansion, contraction, water hammer or other causes. Look for undue vibration particularly in piping connections to the boiler and the vessel. Where excessive vibration is found, examine connections and parts for a tendency to crystallize.

7.5 DEVICES.

7.5.1 Temperature Indicating Devices. All temperature indicating devices shall be observed for indications of excessive temperatures, particularly during and immediately following the time when high load demands are made on the boiler and the vessel.

7.5.2 Metering and Recording Devices. While the boiler is operating under normal conditions, observe the operation of all metering and recording devices. When there is evidence that any such device is not functioning properly, it shall be adjusted, repaired, or replaced as necessary.

7.6 VALVES.

7.6.1 Blow-Down Valves. Test the freedom of each blow-down valve and its connections by opening the valve and blowing down the boiler for a few seconds. Determine whether the valve is excessively worn or otherwise defective, and whether there is evidence of restrictions in the valve or connected piping preventing proper blow-down of the boiler.

7.6.2 Stop and Check Valves. While the boiler (or vessel) is operating, inspect the operating condition of each stop and cheek valve where possible. Serious defects of externally controlled stop valves maybe detected by operating the valve when it is under pressure. Similarly, defects in check valves maybe detected by listening to the operation of the valve or by observing any excessive vibration of the valve as it operates under pressure.

7.63 Pressure Reducing Valves. While there is pressure on the system open and then close the by-pass valve, as safety and operating conditions permit and observe the fluctuation of the pressure gage pointer as an aid to determining possible defects in the operation of the pressure reducing valve or the pressure gage. Look for evidence that may indicate improper condition of the relief or safety valves provided for pressure reducing valves.

7.6.4 Safety & Safety Relief Valves. Inspect the valves for evidence of leaks and proper operation. Check the popping pressure and blowdown of safety valves by allowing the pressure of the boiler to rise so that the valves lift. The valve drains and discharge shall be inspected to ensure that they are free from obstructions and installed according to the ASME Code. For multiple valve operations, where an accumulation test cannot be accomplished, the freedom of the valve to lift shall be checked using the lifting lever provided the pressure is within 10% of the valve set pressure. Similarly, safety relief valves should be checked by using the lifting lever. Proper installation and operation is necessary prior to issuing an inspection certificate.

7.7 BOILER AUXILIARIES. While the boiler is operating under normal conditions, observe the operation of all boiler auxiliaries for any defects which may prevent the proper functioning of the boiler or which may indicate a lack of proper maintenance. The unnecessary use of multiple auxiliaries or the use of a large auxiliary during a light load period (when a smaller auxiliary could be substituted) should be discouraged. The maximum use of steam driven auxiliaries short of atmospheric exhaust should be encouraged. Steam leaks wastage to atmosphere, and so forth, should be called to the attention of the operating personnel. Particular attention should be given to deaerator venting practice. Venting should beheld to the minimum required to preclude oxygen entrainment in the feedwater. When intermittently operating condensate pumps are used, look for any tendency toward the creation of a vacuum when a pump starts. If this happens, the installation of a small continuously operating float throttled condensate pump (in parallel with intermittently operating pumps) will ensure a condensate flow at all times. If there area number of intermittently operating condensate pumps, it may be possible to convert one of them (if of small enough capacity) to continuous throttled operation.

7.8 BOILER AND FEEDWATER TREATMENT. The operation of equipment provided for boiler and feedwater treatment shall be observed and the materials and procedures used for boiler and feedwater treatment should be checked to ensure adequate protection against scale and corrosion in the boiler, plant, equipment and distribution system. The internal condition of the boilers, as evidenced from inspections required under Chapter 4, Internal Inspection shall be the determining factor regarding the adequacy of materials and procedures used in boiler and feedwater treatment. The certificate shall be withheld if an effective boiler water treatment program is not being implemented.

7.9 FUEL HANDLING PRACTICES. The inspector shall check the fuel handling practices and make recommendations toward the elimination of multiple handling heating of tanks not in use, and the simultaneous use of heaters in a duplex fuel oil pump and heater set where load conditions do not require this procedure. Heating of entire tanks should be avoided. Heating within a tank should be limited to heating at the suction point only. With respect to residual fuel oil tanks, frequent tank changes (extending to the tank bottom) should be encouraged as a means of precluding sludge buildup.

CHAPTER 8. REPAIRS AND ALTERATIONS

8.1 GUIDANCE. Repairs to the equipment maybe necessary before certification. The activity may already be aware of necessary repairs prior to any inspections and tests. Prior to issuing a certificate, all deficiencies which cause an unsafe condition must be corrected. The repairs must be completed in accordance with the applicable code. For pressure parts, repairs must be performed in accordance with the ASME Code. Repairs to unstamped pressure vessels are prohibited by anyone other than the original manufacturer or his authorized representative. For combustion control safeguards (burner safety controls), the equipment must be repaired to meet the requirements of the National Fire Codes or ANSI/ASME CSD-1 as applicable. When deficiencies are found in the pressure parts of MILSPEC pressure vessels or pressure vessels of undetermined Code origin, the vessels must be rendered inoperable in such a way as to prevent further use. To ensure safe operating conditions repairs to flame safeguard equipment shall only be made by the manufacturer or his authorized representative.

8.2 CONTRACTOR REPAIRS. Repairs and alterations to boilers and unfired pressure vessels by welding shall be made by a contractor holding a NBBI (R) stamp in accordance with Chapter III of the National Board Inspection Code. For welding repairs or alterations, the contractor shall complete a National Board Form R-1 and stamping and nameplate attachment is required.

8.3 SETTING SAFETY VALVES. The setting of safety valves of power boilers within the limits of ASME Section I are adjustments. Other changes in settings, welding, or machining are repairs. Repairs and adjustments of safety valves are not valid unless performed by the manufacturer or a valve repair company. Repairs by the Government are prohibited. The contractor shall be required to affix a National Board VR name-plate to the repaired valve. Whether the safety valve is repaired or adjusted, the breaking of the seal, the setting of the valve and the resealing of the valve shall be documented. Power boilers are not certifiable unless all safety valves are sealed and tagged.

8.4 RECORDS. If this information is acceptable to the inspector, the repairs or alterations shall proceed and be inspected. Upon approval of the work by the inspector, the activity shall make a permanent record of the repairs or alterations.

CHAPTER 9. INSPECTION CERTIFICATES AND REPORTS

9.1 PROCEDURES FOR SUBMITTING REPORTS AND FORMS. The following hard copy reports and form, or EPD approved computer reports, will be used in the inspection and testing of boilers and unfired pressure vessels. An example of each is contained in Appendix D.

9.1.1 Inspection Reports - Boilers and Unfired Pressure Vessels. The applicable report is to be completed by the inspector to record the condition of the boiler or unfired pressure vessel, the tests performed, and the issuance of the certificate. One copy is to be retained in the activity files for a period of at least 2 years and one copy forwarded to the Geographic EFD within 30 days of the inspection. The inspector shall promptly notify the Public Works Officer of the activity whenever inspection reports indicate safety deficiencies pressure reductions and unserviceability.

9.1.2 Inspection Certificate for Boilers - Unfired Pressure Vessels; NAVFAC Form 9-11014/32(347). A current and valid certificate, or commercial equivalent authorized by NAVFACENGCOM for contract inspection, shall be posted **on,** or near, the equipment, under a clear protective covering. Operation of the equipment without the certificate is not authorized. The certificate shall be issued under the following conditions:

- No Deficiencies: The inspector shall complete and sign after the test or inspection.
- Deficiencies Not Affecting Operating Safety May be issued but corrections must be recorded on the Inspection Report-Boilers.
- Deficiencies Affecting Operating Safety Withheld until corrected and reinspected. The activity Public Works Officer and the EFD shall be notified in writing listing the specific deficiencies.
- Pressure Reduction: Issued for the reduced working pressure. Oral notification confirmed in writing, shall be made by the inspector to the activity Public Works Officer and the EFD.
- Unserviceable No certificate maybe issued. The inspector shall notify the activity Public Works Officer and the EFD in writing of the deficiencies.

- Vessels of unknown origin Certificate maybe issued provided it is accompanied by a plan of action with milestones to replace the vessel prior to the next inspection cycle.

CHAPTER 10. MAXIMUM ALLOWABLE WORKING PRESSURE

10.1 GUIDANCE. The MAWP shall be determined as described in the National Board Inspection Code. The following paragraphs provide further guidance on MAWP. Defects or damage discovered during the inspection shall be repaired in accordance with Chapter 8. If, in the judgment of the inspector, a steam or hot water boiler or vessel is unsafe for operation at the pressure previously approved the pressure shall be reduced proper repair made, or the boiler or vessel shall be condemned.

10.2 STANDARD BOILERS. (Including expansion drums on high temperature water installations.) The maximum allowable working pressure of a boiler built in accordance with the Code shall in no ease exceed the pressure indicated by the manufacturer's identification stamped or east upon the boiler or upon a plate secured to it. Specific requirements governing the maximum allowable working pressure on the following standard boilers shall be followed.

10.2.1 Standard Water Tube Boilers. The maximum allowable working pressure on standard water-tube boiler, the tubes of which are secured to east-iron or malleable-iron headers, or which have cast-iron mud drums, shall not exceed 160 psig.

10.2.2 Standard Cast-Iron Steam Boilers. The maximum allowable working pressure for a standard cast-iron steam boiler shall not exceed 15 psig. Standard east-iron hot water boilers operating at temperatures not to exceed 250° may be operated at pressures up to 160 psig.

10.3 NONSTANDARD BOILERS

10.3.1 Nonstandard Riveted Boilers. The maximum allowable working pressure on the shell of a nonstandard riveted heating boiler shall be determined in accordance with the Code, except that in no ease shall the maximum allowable working pressure of a steam heating boiler exceed 15 psig or a hot water boiler exceed 160 psig at a temperature not exceeding 250°F.

10.3.2 Nonstandard Welded Boilers. The maximum allowable working pressure of a nonstandard steel or wrought iron heating boiler or welded construction shall not exceed 15 psig for steam. For other

than steam service, the maximum allowable working pressure shall be calculated in accordance with the Code.

10.3.3 Nonstandard Cast Iron Boilers. The maximum allowable working pressure of a nonstandard boiler composed principally of cast iron shall not exceed 15 psig for steam service of 30 psig for hot water service. The maximum allowable working pressure of a nonstandard boiler having cast iron shell or heads and steel or wrought iron tubes shall not exceed 15 psig for steam service or 30 psig for hot water service.

10.4 CALCULATIONS OF MAXIMUM ALLOWABLE WORKING PRESSURE. When inspection indicates that the thickness of the plate or the strength of any joint is leas than that on which the current maximum allowable working pressure is based, or when it is impracticable to apply the required hydrostatic test, anew maximum allowable working pressure shall be calculated in accordance with the rules of the Code. The following factors of safety shall be used and increased by the inspector if the condition and safety of the boiler demand it:

- The lowest factor of safety permissible on existing installations shall be 4.5 except for horizontal return tubular boilers having continuous longitudinal lap seams more than 12 feet in length where the factor of safety shall be 8, and when this latter type of boiler is removed from its existing setting it shall not be reinstalled for pressures in excess of 15 psig.
- Reinstalled or secondhand boilers shall have a minimum factor of safety of 6 when the longitudinal seams are of lap riveted construction and a minimum factor of safety of 5 when the longitudinal seams are of butt and double strap construction.
- The maximum allowable working pressure for a vessel in operation shall be computed with the appropriate formulas in the tide, using dimensions actually determined by the inspection for the thickness and twice the estimated corrosion allowance before the next inspection and making suitable allowance for the other loadings enumerated in the Code to be considered in the design of a vessel. The maximum allowable working pressure of vessels designed and built with one or more open for which the closures are auxiliary equipment not part of the pressure vessels, shall be determined only after due consideration of the auxiliary equipment to be used as

closures. The minimum factor of safety shall not be less than 4 and shall be increased by the inspector if the condition and safety of the vessel demand it. The condition of the vessel and the particular service to which it is subject shall be the determining factors.

10.5 FACTOR OF SAFETY. The factor of safety is "built in" to the modern ASME Code formulas of Section I, PG-27.1 through PG-27.4. For reference, the original formula is

$$P = (TS \times t \times E)/(R \times FS)$$

Where P = pressure in psi
TS = tensile strength, psi
t = thickness, inches
E = efficiency of the longitudinal seam
R = inside radius, inches
FS = factor of safety

CHAPTER 11. MISHAP OR PROPERTY DAMAGE REPORTING

11.1 REPORTING REQUIREMENTS. OPNAVINST 5102.1 series requires that incidents which satisfy the following criteria be reported to the activity Safety Office for investigation and reporting to the Naval Safety Center:

- Damage to property involving a repair or replacement cost equal to or exceeding $10,000.

OR

- Any incident involving a lost time employee mishap.

This instruction also encourages reporting of incidents where serious injury to Naval personnel was possible or if there was a "lesson to be learned'.

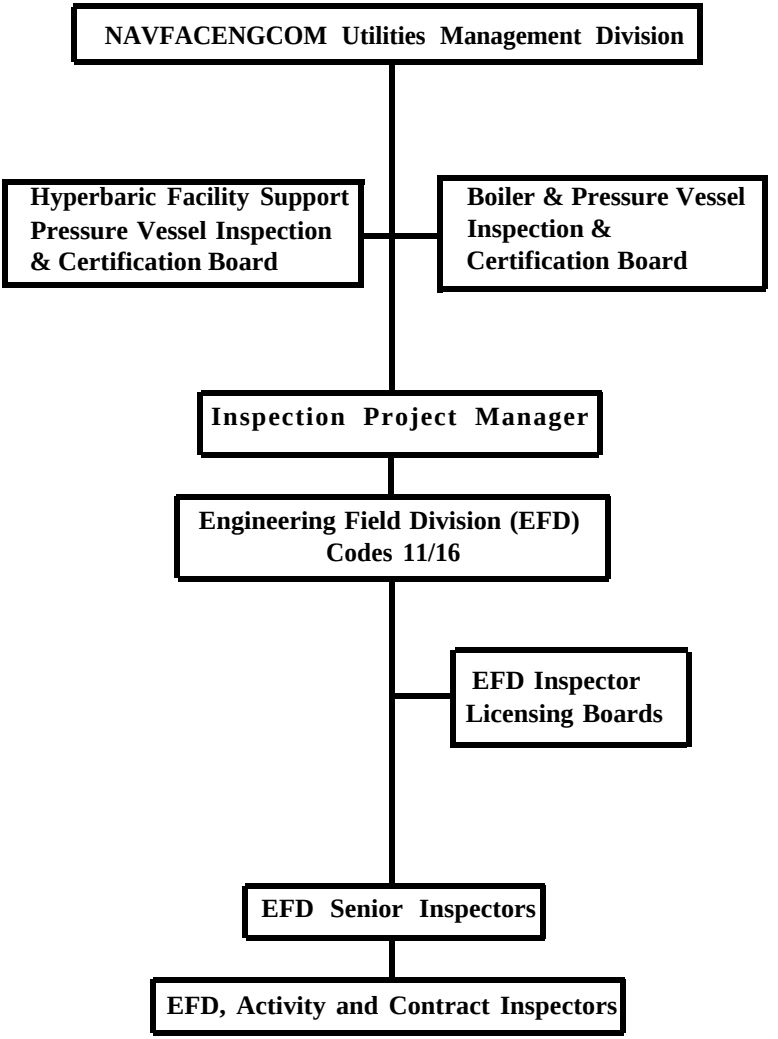
11.2 INFORMATION COPIES. A copy of the required report for all incidents relating to the construction, repair, operation and maintenance of the boilers and unfired pressure vessels covered by this manual shall be forwarded to the geographic EFD of the NAVFACENGCOM for information.

APPENDIX A

INSPECTION PROGRAM ORGANIZATION

Appendix A

The NAVFACENGCOM Boiler and Unfired Pressure Vessel Inspection Program Quality Assurance Organization



APPENDIX B

DUTIES & QUALIFICATIONS OF SENIOR EFD INSPECTORS

Appendix B

DUTIES AND QUALIFICATIONS OF THE SENIOR INSPECTOR AT THE NAVFAC EFDS

The duties of the Senior Inspector at each EPD are as follows

1. Monitor status of inspections at all activities.
2. Perform random checks on contractor inspections.
3. Accompany all activity and EPD inspectors on an inspection at least once every two years.
4. Provide consultation services to EFD and activity inspectors.
5. Review all inspection reports.
6. Coordinate boiler water and clean steam programs with the Boiler and Pressure Vessel Inspection program.
7. Provide liaison with the NAVFACENGCOM inspection program coordinator.
8. Conduct workshops for inspectors once every two years.
9. Coordinate inspections of new boilers and pressure vessels as requested by NAVFAC ROICCs.
10. Propose changes to MO-324.
11. Attend Senior Inspector workshops.
12. Ensure activities correct safety violations.
13. Enlist NAVFAC support for correction of violations when necessary.
14. Void boiler and unfired pressure vessel inspection certificates when appropriate.

The qualifications of the Senior Inspector at EFDs shall be as follows:

1. Possess a valid NAVFAC Boiler Inspector Certificate of Competency
2. Possess a valid EFD Boiler Inspector's License.
3. Have at least 5 years of experience in the inspection of high pressure power boilers.

APPENDIX C

PROCEDURES FOR LAY-UP OF BOILERS

Appendix C
PROCEDURES FOR LAY-UP OF BOILERS

C.1 GUIDANCE. When a boiler is taken out of service, the boiler should be cooled until the water is below the atmospheric boiling point, but not below 180°F; the boiler should be emptied and flushed out. An inspection should be made to determine what repair work is necessary and what mechanical and chemical cleaning should be done. A decision should then be made on whether to employ dry storage or wet storage. Since freshly cleaned metal surfaces are much more vulnerable to corrosion than surfaces that have operational oxides on them, it is much preferred to delay chemical cleaning until the boiler is ready to be returned to service.

C.2 DRY STORAGE. This procedure is preferred for boilers out of service for extended periods of time or in locations where freezing temperatures may be expected during stand-by.

C.2.1 The boiler should be thoroughly dried, since any moisture left on the metal surface would cause corrosion to occur on long standing. After drying precautions should be taken to preclude entry of moisture in any form from steam lines, feed lines, or air.

C.2.2 Moisture absorbing material, such as quicklime at the rate of 2 lb., or silica gel at the rate of 5 lb., for 30 cu. ft. of boiler volume, is placed on trays inside the drums to absorb moisture from the air. The manholes should then be closed and all connection on the boiler should be tightly blanked. The effectiveness of materials for such purposes and need for their renewal may be determined through regular internal boiler inspections.

C.2.3 Alternatively, air dried externally to the boiler maybe circulated through it. The distribution should be carefully checked to be sure the air flows over all areas.

C.2.4 It is usually desirable in the case of large utility boilers (particularly the once-through type) to simply drain the boiler while feeding nitrogen to the boiler vents and maintaining a 5 psig nitrogen pressure during the storage period.

C.3 WET STORAGE. A wet procedure maybe used for a boiler to be placed in a stand-by condition. Wet storage is particularly useful if the stand-by boiler may be required for service at short notice or it it is impractical to employ a dry storage procedure. The method is not generally employed for reheaters or for boilers which maybe subject to freezing temperatures. Several procedures have been employed.

C.3.1 The empty boiler should be closed and filled to the top with water conditioned chemically to minimize corrosion during stand-by. Water pressure greater than atmospheric should be maintained within the boiler during the storage period. Ahead tank may be connected to the highest vent of the boiler to maintain a pressure above atmospheric.

C.3.2 For a short storage period condensate or feedwater containing approximately 100 to 200 ppm of sodium sulfite may be used. If the superheater is of the drainable type, it can also be filled with the same treated water by overflow from the boiler.

C.3.3 If the superheater is not drainable, refer to plant operating manual or request assistance from your cognizant EFD.

C.4 ALTERNATIVE WET LAY-UP METHODS. The boiler may be stored with water at normal operating level in the drum and nitrogen maintained greater than atmospheric pressure in all vapor spaces. To prevent in-leakage of air, it is necessary to supply nitrogen at the vents before the boiler pressure falls to zero as the boiler is coming offline. If boiler pressure falls to zero, the boiler should be fired to reestablish pressure and the superheater and reheater thoroughly vented to remove air before nitrogen is admitted. All partly filled steam drums arid superheater and reheater header should be connected in parallel to the nitrogen supply. If nitrogen is supplied only to the steam drum, nitrogen pressure should be greater that the hydrostatic head of the longest vertical column of condensate that could be produced in the superheater. Rather than maintain the water in the boiler at normal operating level with a nitrogen cap, it is sometimes preferable to drain the boiler completely, applying nitrogen continuously during the draining operation and maintaining a pressure of nitrogen greater than atmospheric throughout the draining and subsequent storage.

APPENDIX D - REPORTS AND FORMS

INSPECTION REPORT - BOILER

EXP DATE DATE OF INSPECTION	A. ( ) INTERNAL - WATERSIDE ( ) B. ( ) PRESSURE TEST - STRENGTH ( ) C. ( ) EXTERNAL / OPERATIONAL	FIRESIDES ( ) TIGHTNESS ( )
NEXT WATERSIDES INSPECTION DUE:		NEXT STRENGTH TEST DUE:

1. From:				14. Certificate ISSUED
2. To:				15. BOILER INSPECTOR
3. MANUFACTURER				NAVY OR NATIONAL BOARD No. NAVPAC No. LICENSE No.
4. PROPERTY No.	5. MFG SERIAL No.	6. MPG MODEL No.		16. REASON FOR NOT ISSUING A CERTIFICATE
7. BUILDING No.	8. YEAR BUILT	9. CAPACITY		
10. FUEL	11. PRESSURE DESIGN	OPER.	TEST	
12. FEEDWATER TREATMENT	13. TYPE OF BOILER			

17. BOILER USE	18. COMBUSTION CONTROL (MFG NAME)
19. COMBUSTION %CO_2 % EXCESS O_2	20. FLUE GAS TEMPERATURE °F

SAFETY DEVICES/SAFETY VALVES

21. MANUFACTURER	22. No..	SIZE	23. PSI SETTING	24. CONDITION

FIRING EQUIPMENT

	IN SERVICE	ALTERNATE
25.	MANUFACTURER	MANUFACTURER
26.	TYPE	TYPE
27.	FUEL TYPE	FUEL TYPE
28. INSPECTOR'S COMMENTS		
29. ATTACHMENTS		30. SIGNATURE

Instructions for Completing
Inspection Report - Boiler

Use a separate form for each boiler. The following subparagraph numbers refer to number blocks on the report.

1. From Enter the name of inspection department performing the inspection.

2. To Enter the title of the activity for whom the inspection is being made.

3. Manufacturer: Enter the name of the manufacturer.

4. Property No.: Enter the identification number as indicated by the activity.

5. Manufacturer's Serial No.: Enter the serial number as indicated by the manufacturer.

6. Manufacturer's Model No.: Enter the model number as indicated by the manufacturer.

7. Building No.: Enter the building or structure number in which the boiler is located.

8. Year Built: Indicate the calendar year in which the boiler was constructed.

9. Capacity Show capacity in millions of BTUs per hour. 1 lb per hour of steam is approximately equal to 1000 BTUs. 1 boiler horsepower is approximately equal to 33,500 BTUs per hour.

10. Fuel: Enter appropriate fuel, e.g., natural gas, No. 2-6 fuel oil, propane, coal solid waste, etc.

11. Pressure Enter the design, operating, and test pressures (psig).

12. Boiler Feedwater Treatment: Enter if treatment is Sat or Unsat.

13. Type: Enter type of boiler, e.g., cast iron, water tube, firetube.

14. Certificate Issued: Enter yes or no.

15. Boiler Inspector: Signature of authorized inspector. Indicate the Navy Certificate of Competency number and/or EFD License to inspect. Contract inspectors are to indicate their EFD Authorizations to Inspect.

16. Reason for Not Issuing Certificate: Enter the reason for not issuing the certificate.

17. Boiler Use: Enter the primary purpose of the boiler (space heating, power generation, cogeneration, process load, etc).

18. Combustion Control: Enter the combustion control manufacturer and indicate if automatic or semi-automatic.

19. Combustion Enter appropriate percentages.

20, Flue Gas Temperature: Enter, in degrees Fahrenheit, the temperature of the flue gas immediately after the boiler.

21. Manufacture Enter the name of the safety valve manufacturer.

22. Number and Size: Enter the number and size of the safety valves.

23. PSI Settings: Enter the lifting pressure of the safety valves.

24. Condition Enter the condition of the safety valve or valves as Sat or Unsat.

25. Manufacture Enter the name of the primary fuel firing equipment manufacturer in column 1 and the alternate fuel in column 2.

26. Type Enter the type of firing equipment (including the alternate).

27, Fuel Grade Enter the primary and secondary fuel types, grade, e.g., natural gas, #2 fuel oil, #6 fuel oil, etc.

28. Inspector's Comments: Enter any comment regarding boiler discrepancies, etc.

29. Attachments: Enter yes or no.

30. Signature: Signature of commanding officer or other person authorized to forward the report.

UNFIRED PRESSURE VESSEL REPORT

EXP. DATE DATE OF INSPECTION	TYPE OF INSPECTION A ( ) INTERNAL ( ) EXTERNAL ( ) B ( ) PRESSURE TEST C ( ) OPERATIONAL TEST
1. FROM	9. CERTIFICATE ISSUED YES ( ) NO ( )
2. TO:	10. BOILER INSPECTOR
	NAVY OR NATIONAL BOARD NO. NAVFAC NO. LICENSE NO.
3. MANUFACTURER	11. REASON FOR NOT [SWING A CERTIFICATE
4. PROPERTY NO. / 5. SERIAL No.	

6. BUILDING NO.	7. YEAR BUILT	8. CAPACITY (CU. FT.)

12. PRESSURE DESIGN	OPER.	TEST	13. UPV USE

SAFETY VALVES

14. MANUFACTURER	15. CAPACITY (cm)	16. NO. OF VALVES

17. SIZE ( ) ( )	18. SETTING (PSI) ( ) ( )	19. VALVE CONDITION

20. INSPECTORS COMMENTS:

21. ATTACHMENTS	22. SIGNATURE

Instructions for Completing
unfired Pressure vessel (UPV) Report

Use a separate form for each UPV. The following subparagraph numbers refer to number blocks on the report.

1. From: Enter the name of inspection department performing the inspection.

2 To Enter the title of the activity for whom the inspection is being made.

3. Manufacturer: Enter the name of the manufacturer.

4. Property No.: Enter the identification number as indicated by the activity.

5. Manufacturer's Serial No.: Enter the serial number as indicated by the manufacturer.

6. Building No.: Enter the building or structure number in which the UPV is located.

7. Year Built: Indicate the calendar year in which the UPV was constructed.

8. Capacity Enter capacity in cubic feet.

9. Certificate Issued Enter yes or no.

10. Boiler Inspector: Signature of authorized inspector. Indicate the Navy Certificate of Competency number and/or EFD License to inspect. Contract inspectors are to indicate their EFD Authorizations to Inspect.

11. Reason for Not Issuing Certificate Enter the reason for not issuing the certificate.

12 Pressure Enter the design, operating and test pressures (psig).

13. UPV Use: Enter the primary purpose of the UPV (shop air, control air, etc.)

14. Manufacturer: Enter the name of the safety valve manufacturer.

15. Safety Valves Capacity (CPM): Enter capacity of valves.

16. Number of Valves: Enter the number of safety valves.

17. Size of Safety Valves: Enter the size of the safety valves in inches.

18. Setting (PSI): Enter safety valve setting.

19. Valve Condition Enter Sat or Unsat.

20. Inspector's Comments: Enter any comment regarding UPV discrepancies, etc.

21. Attachment: Enter yes or no.

22. Signature: Signature of commanding officer or other person authorized to forward the report.

Inspect.ion Certificate for Boiler-Unfired Pressure Vessel
Form NAVFAC 9-11014/32 (3/67)

DEPARTMENT OF THE NAVY

NAVAL FACILITIES ENGINEERING COMMAND

INSPECTION CERTIFICATE FOR: ❑ BOILER ❑ UNFIRED PRESSURE VESSEL

ACTIVITY	LOCATION	SERIAL NO.
NATIONAL BOARD NO.	NAME	PRESSURE ALLOWED p.s.i.

THIS CERTIFICATE EXPIRES

THIS BOILER OR VESSEL HAS BEEN INSPECTED AND APPROVED FOR OPERATION AT A PRESSURE SHOWN ABOVE:

TYPE OF INSPECTION

❑ EXTERNAL ❑ INTERNAL ❑ PRESSURE ❑ OPERATIONS

NAME	DATE	FIELD DIVISION INSPECTOR

POST THIS CERTIFICATE UNDER GLASS NEAR THE BOILER OR VESSEL

NAVFAC 9-11014/32 (3-67) *Supersedes NAVDOCKS 3810 & 3807* S/N 0105-LF-823-0000 ☆ U.S. GPO: 1966—805-807/66922 2-1

Instructions for Completing Inspection Certificate for Boiler-Unfired Pressure Vessel NAVFAC (11014/32 (3-67)

1. Inspection Certificate for: Place xx in appropriate box.

2 Activity: Name of activity.

3. Location: City and state.

4. Serial No.: Manufacturer’s number from nameplate.

5. National Board No.: When available.

6. Make: Manufacturer's name.

7. Pressure Allowed: Taken from nameplate unless reduced as a result of inspection.

8. This Certificate Expires: Month and year of expiration depending on inspection frequeney.

9. Type of Inspection: Place xx in appropriate box or boxes.

10. Name: Inspector will sign here.

11. Date Date of signature.

12. Inspector: Will place his National Board Number or NAVFAC Certificate of Competency Number and EFD license (Authorization to Inspeet) here.

APPENDIX E

PMI CHECKLIST FOR SMALL. BOILERS

APPENDIX E
PMI CHECKLIST for STEAM BOILERS
(capacities of 400,000 BTUH Input or less)

STEAM BOILERS

1. Observe condition of flame. Correct if flame is smokey or if burner starts with puff. Flame should not impinge on furnace walls.	Weekly
2. Test the low water fuel cut offs for proper sequencing and operation. Blow down boiler.	weekly
3. Test water colunm or gage glass. Glass must be clean and free of obstructions. Clean dirty glass and replace defective column or glass at once. Defects include leaking gage cocks and glass, excessive corrosion inability to discern water level and improper operation.	weekly
4. Observe operation of condensate of vacuum pumps. Replace or repair defective or leaking pumps.	Weekly
5. Cheek operation of chemical feed pots and feed pumps. Repair or replace defective equipment.	Weekly
6. Test flame detection devices and associated automatic fuel cut off valves Loss of flame should shutoff flow of fuel to the burner. Repair or replace if device or valves are found to be defective.	Monthly
7. Inspect steam supply and condensate return piping valves radiators, and traps for leaks, excessive rust and damaged or lack of insulation. Blowdown strainers. Repair or replace individual items as needed.	Monthly
8. Inspect fuel supply systems and piping in boilers for leaks, loss of insulation etc. Repair or replace as needed. Replace cartridges for in-line oil filters. Adjust oil pressure as prescribed by the manufacturer. Ensure both oil supply and return lines have a fusible in-line valve.	Monthly

9. Check condition of safety valves. Test valve with tri-lever. Valves should preferably be the pressure and temperature type. Leaking safety valves must be replaced. No obstruction such as another valve, long pipe length, or constriction is permissible between the boiler and the safety valve. The overflow from the valve should be free of obstructions and piped to within 4 inches of the floor or to a floor drain.	Monthly
10. Check boiler room drains for proper functioning.	Monthly
11. Inspect burner assembly. Evidence of improper fuel nozzle wear, plugging or carbon build-up on the nozzle is cause for replacement. Adjust equipment for proper combustion after replacing the old nozzle with a new one.	Monthly
12. Inspect burner assembly. Replace nozzle and falters on oilburning equipment. Clean, check and adjust electrodes.	Annually
13. Internal and external inspection of heating surfaces after cleaning. Fireside surfaces should be free of soot. Cracked surfaces will require repair or replacement of the furnace (tiring chamber). Repair to pressure parts requires a certified welder. Evidence of bulges or other deformities indicates defective controls and safety devices or improperly sized and adjusted burner. Consult a boiler water treatment specialist if there is evidence of hard scale on the water side surfaces.	Annually
14. Inspect gas piping, valves, regularly for proper support and tightness. Test for tightness with a soap solution. If a leak is detected, then secure the piping to the boiler and contact the gas company.	Annually
15. Check transformer. Do not interchange transformers of different capacities when replacing defective transformers.	Annually
16. Remove trash, combustibles from the boiler room. Assure ventilation to the boiler.	Annually

17. Check draft, manifold pressure and combustion. Annually
Conduct combustion efficiency test and adjust burner for efficient safe operation. Combustion measurements required are for CO%, CO_2%, O_2%, stack temperature, and boiler room temperature. No smoke or CO should be evident. Overfire draft should be at least .02 inches water gauge (W.G.) for oil burners. Adjust manifold pressure as specified by the manufacturer.

18. Inspect control equipment for proper sequence and Annually
operation. Covers on controllers should be in ‘place. Dust and dirt on control equipment must be removed. Electric contacts that are fouled require cleaning. All wiring should be properly grounded.

19. Calibrate and check operation of gages and meters. Annually
Repair or replace all defective gages and meters, Defects include cracked broken or dirty glass, illegible markings, bent pointers. Place date and initials of testeron the face of the calibrated gages.

20. Check breaching and stack for integrity and tightness. Annually
Breaching and stack should be firmly attached to the boiler in forced draft systems. The breaching and stack should be properly supported and either vertical or sloped upward.

21. Check shell for cleanliness, excessive rust, corrosion Annually
streaks, deformations and cracks. Clean and repair. Repaint to cover bare metal. Assure access doors are in place and in working order.

HOT WATER BOILERS

1. Observe condition of flame. Correct if flame is smokey or if burner starts with puff. Flame should not impinge on furnace walls. Weekly

2. Check fuel supply (oil). Note level of oil in tank. Leaking tanks must be repair or replaced immediately. Weekly

3. Observe operation of circulating pumps. Lubricate pump motor, bearing assembly and flex coupling. Noisy pump motors require repair or replacement. Weekly

4. Test flame detection devices and associated automatic fuel cut-off valves. Loss of flame should shut off flow of fuel to the burner(s). Replace or repair if device or valves are found defective. Monthly

5. Inspect fuel supply systems and piping in boilers for leaks, loss of insulation etc. Repair or replace as needed. Replace cartridges for in-line oil falters. Adjust oil pressure as prescribed by the manufacturer. Ensure both oil supply and return lines have a fusible in-line valve. Monthly

6. Check boiler room drains for proper functioning. Monthly

7. Check condition of safety relief valves. Test valve with tri-lever. Valves should preferably be the pressure and temperature type. Leaking safety valves must be replaced. No obstruction such as another valve, long pipe length, or constriction is permissible between the boiler and the safety valve. The overflow from the valve should be free of obstructions and piped to within 4 inches of the floor or to a floor drain. Monthly

8. Inspect burner assembly. Evidence of improper fuel nozzle wear or plugging or carbon build-up on the nozzle is cause for replacement. Adjust equipment for proper combustion after replacing the old nozzle with anew one Monthly

9. Inspect burner assembly. Replace nozzle and falters on Annually

oil burning equipment. Clean, check and adjust electrodes.

10. Internal and external inspection of heating surfaces after cleaning. Fireside surfaces should be free of soot. Cracked surfaces will require repair or replacement of the furnace (firing chamber). Repair to pressure parts requires a certified welder. Evidence of bulges or other deformities indicates defective controls and safety devices or improperly sized and adjusted burner. Consult a boiler water treatment specialist if there is evidence of hard scale on the water side surfaces. Annually

11. Inspect gas piping, valves, regularly for proper support and tightness. Test for tightness with a soap solution, never a flame. If a leak is detected then secure piping to the boiler and contact the gas company. Annually

12. Check transformer. Do not interchange transformer of different capacities when replacing defective transformers. Annually

13. Inspect area around boiler for cleanliness, combustibles etc. Remove trash combustibles from the boiler room. Assure adequate ventilation to the boiler. Annually

14. Inspect hot water supply and return piping and valves, dual control unit for leaks, excessive rust, and damaged or lack of insulation. Repair or replace as needed. Annually

15. Check draft, manifold pressure and combustion. Conduct combustion efficiency test and adjust burner for efficient safe operation. Combustion measurements required are for CO%, CO_2%, O_2%, stack temperature, and boiler room temperature. No smoke or CO should be evident. Overfire draft should be at least .02 inches water gauge (W.G.) for oil burners. Adjust manifold pressure as specified by the manufacturer. Annually

16. Check expansion tank and air eliminator equipment for leaks, corrosion, etc.Repair or replace defective equipment. Annually

17. Inspect control equipment for proper sequence and Annually

operation. Covers on controllers should be in place. Dust and dirt on control equipment must be removed. Electric contacts that are fouled require cleaning. All wiring should be properly grounded.

18. Calibrate and check operation of gages and meters. Repair or replace all defective gages and meters. Defects include cracked, broken or dirty glass, illegible markings, bent pointers. Place date and initials of tester on the face of the calibrated gages. — Annually

19. Check breaching and stack for integrity and tightness. Breaching and stack should be firmly attached to the boiler in forced draft systems. The breaching and stack should be properly supported and either vertical or sloped upward. — Annually

20. Check shell for cleanliness, excessive rust, corrosion streaks, deformations and cracks. Clean and repair. Repaint to cover bare metal. Assure access doors are in place and in working order. — Annually

Appendix F
What To Expect When The Boiler Inspector Calls

The following article is reprinted unabridged with the permission of HEATING, PIPING and AIR CONDITIONING. The author is John G. Gillissie, a field representative of the National Board of Boiler & Pressure Vessel Inspectors.

The article is provided as a general guide for use by activities when preparing boilers for inspection. The text of MO-324 contains further guidance.

WHAT TO EXPECT WHEN THE BOILER INSPECTOR CALLS

Here's what you can and should do to help him to ensure the safety and integrity of your boiler plant.

Boilers are so common and essential that their safe and effective operation can easily be taken for granted. With boiler safety laws widely adopted and enforced, boiler accidents have become relatively rare. Yet the potential for injury and destruction still exists with any boiler or pressure vessel. A careful consistent program of maintenance and third-party inspection is fundamental to boiler safety.

That's why you as a boiler owner or user, can count on periodic visits from an inspector commissioned by the National Board of Boiler and Pressure Vessel Inspectors and authorized by the legal jurisdiction in which you operate. His visit is mandated by the poke powers of that jurisdiction to maintain public safety.

Here is what to expect-and what you can and should do to help-when the authorized inspector visits you, based on the National Board Inspection Code.

Boilers bearing the ASME and National Board stamps are inspected during manufacture by a National Board commissioned inspector to assure conformance to the ASME Boiler and Pressure Vessel Code. They are then inspected at installation and at designated periods thereafter, depending on the regulations that govern your area. Because thorough boiler inspections are essential the following directions for them have been carefully drawn up. In some eases, these instructions appear as recommendations in the National Board Inspection Code although your local regulations probably make them mandatory.

The commissioned inspector visiting you will know these regulations and will understand what causes boiler deterioration and accidents. He will be conscientious and careful in his observations, taking sufficient time to make his examination thorough in every way and making no final statement about conditions not personally observed. He will not accept testimony of others. If he cannot make a thorough inspection, he will note that in his report.

The inspector will request that you as the owner or your representative

be present during the inspection. He may request you or your representative to aid in any physical tests necessary to evaluate the boiler's physical condition.

The inspector will begin by observing the condition of your entire boiler installation, forming an opinion of the care the equipment receives. On entering the boiler area, he will first inspect the boiler externally. The general cleanliness and accessibility of the boiler and its auxiliary apparatus will be noted.

Boiler fittings, valves, and piping will be checked. Any steam or water leak-such as leakage coming from behind insulation, coverings, supports, or settings-or any evidence of leakage will be thoroughly investigated and any necessary corrective action pointed out. You may be asked to remove insulation to locate the source of leakage or to determine the extent of suspected corrosion.

POWER BOILER INSPECTION

External inspection of power boilers (operating pressures greater than 15 psig) is slightly different from that of heating boilers. For power boilers, the inspector will compare the pressure indicated on the pressure gauge with readings on other gauges in the same system or, if necessary, with a standard test gauge. He will observe the readings during tests, such as the reduction in pressure when testing the low water fuel cutoff control. Defective gauges must be replaced.

Next, the inspector wilI observe the blowdown of the water gauge in the normal manner and how promptly the water returns. A sluggish response may indicate an obstruction in the pipe connection to the boiler, which must be corrected. During the water level gauge test, water and steam connections will be blown separately to ensure both are clear. The inspector will also determine that the boiler water level indication is accurate.

Safety valves come next. The inspector will check the nameplate data of the safety valves to assure that they are ASME/National Board certified and that their relieving capacity is sufficient to safeguard the boiler under full firing conditions. He will also assure that factory seals have not been broken. If the set pressure does not exceed 400 psi, safety val-

ves are tested by allowing the boiler pressure to rise to the popping pressure and subsequently fall.

If checking the actual popping pressure and blowdown is not practical, the boiler operator, while being observed by the inspector, will test the valve for free operation by using the lifting lever, provided the boiler pressure is 75 percent or more of the set pressure. This method is the only practical way to test multiple safety valves unless an accumulation test is made.

At pressures above 400 psi evidence must be shown that the valves were tested under pressure or dismantled, overhauled, and tested and their popping pressures and blowdown adjusted where necessary within a reasonable period of time acceptable to the inspector. Your best assurance that the safety valves have been properly repaired or refurbished is to have this work carried out by an organization that holds, a National Board "VR" (safety valve repair) certificate of authorization.

Alternatively, the owner or user may elect to make the actual popping test just described. If the valve has a discharge pipe, the inspector will determine whether the drain opening in the pipe is free to an atmospheric exhaust area.

When inspection reveals that a safety valve is leaking, sticking or not opening and closing properly, the boiler will be taken out of service. The valve must then be replaced or repaired.

The inspector will next observe how the low water fuel cutoff or feed controls respond when the drain is opened he will check how promptly the system returns to normal as when the alarm or the feed pump stops. A sluggish response may indicate an obstruction in the pipe connections to the boiler. If the controls, where provided, are inoperative or the correct water level is not indicated the boiler will be taken out of service until the unsafe condition has been corrected.

Piping, connections, and fittings will also be carefully examined by the inspector to ensure that there is provision for expansion and adequate support. Steam and water piping and fittings will be examined for leakage. Any leakage or other defects must be corrected. (To avoid water hammer, the locations of the various stop and drain valves should not allow water to accumulate when the valves are closed.) Excessive vibration will be noted and corrective action required.

Connections between individual boilers and the main steam header will be checked for strain caused by the boilers' changing position due to settling or other causes. The inspector will verify that all pipe connections and fittings are properly rated for the service conditions they encounter. He will also observe the blowdown of the boiler in the normal manner, check for freedom of the piping to expand and contract, and ensure that there is no excessive vibration.

During all tests, the inspector will determine whether the actual operating and maintenance practices he observes are acceptable. He will discuss any defects or deficiencies in the boiler or in operating and maintenance practices with the owner or user at this time and recommend corrections.

INTERNAL INSPECTIONS

Since most internal conditions to be observed by the inspector are common to both power and heating boilers, the internal inspection procedures are essentially the same for both types. (Remember, when a boiler is to be prepared for internal inspection, the water must not be withdrawn until the setting has been sufficiently cooled at a rate to avoid damage to the boiler.)

The owner or user should follow these steps to prepare a boiler for internal inspection:

1) Draw off all water and thoroughly wash out the water side.

2) Remove manhole and handhole plates, washout plugs, and inspection plugs in water column connections as required by the inspector. Cool and thoroughly clean the furnace and combustion chambers.

3) Remove all grates from internally fired boilers.

4) Remove insulation and brickwork as designated by the inspector to determine the condition of the boiler, headers, furnace, supports, or other parts.

5) Remove the pressure gauge for testing when required by the inspector,

6) Steam or hot water leakage into the boiler can be prevented by dis-

connecting the pipe or chain locking the valves at the most convenient point or by another means approved by the inspector.

7) Before the manhole or manholes are opened and the inspector enters any part of a boiler connected to a common header with other boilers, close, tag, and preferably padlock the required steam or water system stop valves and open the freeblow drain valves or cocks between the two closed stop valves. Disconnect blowoff lines, where practical, between pressure parts and valves. Open all drains and vent lines.

Before internal inspection is begun, the owner or user must determine that the boiler is safe to enter, is adequately ventilated, and contains no harmful vapors. Applicable safety rules and local regulations must be followed. A person should also standby the boiler all the time the inspector is inside.

With preparations complete, internal inspection begins with insulation and brickwork. Removing boiler insulation material, masonry, or fixed parts for inspection is not normally necessary unless defects or deterioration are suspected or are commonly found in the particular type of boiler being inspected. If evidence of leakage shows on the covering, the insulating material masonry, or a fixed part of the boiler to ensure a thorough inspection. Even drilling or cutting away parts maybe necessary.

The boiler temperature must be low enough to ensure that inspecting personnel will not be exposed to excessive heat. If a boiler has not been properly prepared for an internal inspection, the inspector will decline to proceed. The inspector begins the detailed internal inspection by first examining all exposed metal surfaces on the water side of the boiler for deposits caused by water treatment, scale, oil, or other substances, Oil or scale in the tubes of watertube boilers or on the plates over the fire in any boiler is particularly detrimental. It can have an insulating effect that can lead to overheating weakening, and possible metal failure by bulging or rupture. Since even the smallest amount of oil is dangerous, immediate steps must be taken to clean the affected surfaces and prevent further contamination using chemical or mechanical means as appropriate.

The inspector will examine all stays to determine whether or not they are in even tension. All fastened ends will be examined for cracks. Stays or stay bolts not in tension or adjustment must be repaired. Broken stays

must be replaced. He will test firebox stay bolts by tapping one end of each bolt with a hammer. Stay bolts with holes will be examined for evidence or leaks, which indicate a broken or cracked stay bolt. Broken stay bolts must be replaced.

Manholes and reinforcing plates, as well as nozzles or other connections flanged or screwed into the boiler, will be examined both internally and externally. Whenever possible, observation will be made from the inside to determine whether connections to the boiler are properly made.

All openings leading to external attachments-such as water column connections, low water fuel cutoff devices, openings in dry pipes, and openings to safety valves-will be examined to ensure they are free from obstruction.

The inspector will also check fire surfaces for bulging or blistering. Bulges often result from overheating of the entire thickness of the metal, lowering the strength of the metal and allowing it to be deformed by the pressure in the boiler. Bulges may also be caused by creep or temperature gradients.

Blisters may be caused by metal defects, such as a lamination in which the side exposed to the fire overheats but the opposite side retains its strength due to the cooling effect of the boiler water. Overheating can cause serious boiler deterioration. Metal parts can oxidize, and pressure parts can deform and even rupture, Tubes can also be damaged by poor circulation, steam binding, or deposition of scale.

The inspector will pay particular attention to the plate or tube surfaces exposed to the fire, looking for any deformation such as bulging or blistering, If a bulge or blister shows evidence of leakage or is large enough to weaken the plate or tubes seriously, the boiler will be put out of service for repair. The blister area must be removed, the remaining thickness determined, and repairs made as required. Although a bulge on a water tube must always be repaired, a bulge on a plate, if not extensive, can be driven back into place. Otherwise the affected area must be patched.

Another type of flaw noted by the inspector is cracking. Cracks can result from flaws originating in the material from which the boiler was made, the boiler's basic design and operating conditions, or metal fatigue. They can be accelerated by corrosion. Fire cracks are caused by

the thermal differential when the cooling effect of the water is not adequate to transfer the heat from the metal surfaces exposed to the fire. Cracks can result from a combination of these causes. Cracks noted in shell plates usually are dangerous.

The inspector will examine areas where cracks are most likely to appear, such as the ligaments between the tube holes on watertube boiler drums, between the tube holes on the tube sheet of firetube boilers, areas of stay bolts, at any flange where there maybe repeated flexing of the plate during operation, and around welded pipe and tube connections.

If cracks are suspected, a hydrostatic test to determine their location may be necessary. A suitable nondestructive examination method may also locate such cracks.

The inspector will also look for corrosion, which causes metal surface deterioration. Corrosion can affect large areas or be localized as pitting. Isolated, shallow pitting is not considered serious if it is not active.

Boiler corrosion is usually caused by free oxygen and dissolved salts. If the inspector finds active corrosion, he will advise the owner or user to obtain competent remedial action. To estimate what effect severe corrosion over large areas has on the safe working pressure, the thickness of the remaining sound metal will be determined by ultrasonic examination or by drilling.

Grooving, yet another type of flaw, is a metal deterioration caused by localized corrosion and stress concentration. The inspector will examine all flanged surfaces, particularly the flanges of unstayed heads, as thoroughly as their construction permits. Grooving in the knuckles of such heads is fairly common since they have a slight natural movement that causes a stress concentration.

Boilers with ogee or reversed flanged construction are also prone to grooving but may not be readily accessible for examination. The inspector will insert a mirror through an examination opening to examine as much area as possible. Other examination methods, such as ultrasonics, may be employed. Since grooving is usually progressive, its effect must be carefully evaluated and corrective action taken when it is detected.

Firetubes, water tubes, and piping are examined next. The fireside surfaces of tubes in horizontal firetube boilers usually deteriorate more

rapidly at the ends nearest the fire. The inspector will check the tube ends for serious reductions in thickness. The surfaces of tubes of vertical tubular boilers are more susceptible to deterioration at the ends exposed to combustion. These exposed tube ends in the combustion space will also be checked for serious reductions in thickness.

The inspector will thoroughly examine the waterside surfaces of all tubes for pitting and corrosion. In vertical firetube boilers, excessive corrosion and pitting often occur at and above the water level. Excessive scale on water surfaces must be removed before the boiler is placed back in service.

Watertube surfaces will be carefully examined for corrosion, erosion, bulges, cracks, or any evidence or defective welds. Tubes can become thinned by erosion produced by the impingement of particles of fuel and ash at high velocity or by improperly installed or operated soot blowers. Tube leaks frequently cause serious corrosion or erosion on adjacent tubes.

Fuel and ash also tend to lodge in restricted fireside spaces, as where short tubes or nipples join drums or headers. Such deposits usually cause corrosion if moisture is present. Coal and fuel oils contain sulfur, which is present in ash or soot deposits. Dampness adds hydrogen, and exposure to air adds oxygen. The result is H_2SO_4, not helpful to metal surfaces. Clean this area thoroughly for the inspector's examination.

The inspector will thoroughly examine piping, connections, and fittings for leaks and to ensure adequate provision for expansion and supports. Any leaks or other defects must be corrected. To avoid water hammer, stop and drain valves must be located so that water will not accumulate when the valves are closed. Excessive vibration and its effects must be corrected.

All automatic low water fuel cutoff and water feeding devices will be examined for proper installation. Operating instructions for the devices must be readily available. The inspector will examine the float chamber type control devices for wear. Necessary repairs must be made before the devices are placed back into service.

He will further check that fireside baffles in watertube boilers are in place. If proper baffling is absent, high temperature concentrations often result, causing overheating in portions of the boiler. The location

and condition of combustion arches will be checked to ensure flame impingement will not cause overheating. Any localized heat buildup caused by defective or improperly installed or operated firing equipment must be corrected before the boiler in returned to service.

The inspector will examine the supports and setting of suspended boilers-especially where a boiler is near the setting walls or floor-to ensure ash or soot does not bind or produce excessive strains on the boiler by restricting its movement when operating.

The National Board recommends that under normal operating conditions, safety valves installed on power boilers operating at 400 psi or less be manually tested once a month by the operator and pressure tested once a year. (Under certain operating conditions, these recommendations may not apply.) Actual operating experience will determine how frequently safety valves on power boilers operating at more than 400 psi should be tested.

The inspector will check safety and safety relief valves on heating boilers for the correct set pressure and adequate relieving capacity. Any leaking or deteriorated valve must be repaired by the manufacturer or an authorized safety valve repair facility or be replaced. Discharge pipes must be adequately supported and valves must be properly sealed unless they are nonadjustable.

A common unsafe condition found in both safety and safety relief valves is the failure to open at the set pressure due to buildup of corrosive deposits between the disc and seat.

The National Board recommends that under normal operating conditions, the safety or safety
relief valve on a steam or hot water heating boiler should be tested manually once a week and pressure tested once a year. Again, under certain operating conditions, these recommendations may not apply.

The inspector will next determine that where required, all pressure gauges have been removed and tested and their readings compared to the readings of standard test gauge or a dead weight tester. He will determine whether any steam pressure gauge is exposed either to high temperature from an external source or to internal heat due to lack of protection by a proper siphon or trap. He will also check that provision is made for blowing out the pipe leading to the steam gauge.

If tubes have been replaced or rerolled, the inspector will check for propers workmanship. If tubes are readily accessible, they may have been overrolled. Conversely, if it is difficult to reach the tube ends. they may have been underrolled.

If the inspector requires additional information regarding a leak in a boiler or the extent of a possible defect, he may require that a hydrostatic test be performed. To determine tightness, the hydrostatic test pressure need be no greater than the set pressure of the safety valve having the lowest setting.

The hydrostatic test pressure may not exceed 1.5 times the maximum allowable working pressure. The safety spring may not be compressed to prevent the valve from opening. The safety valve or valves will be removed and each disc held down by means of a gag or testing clamp. A plug device designed for this purpose may be used. Water used in the hydrostatic test should be a least 70°F but may not exceed 120°F during the inspection. If a test is conducted at 1.5 times the maximum allowable working pressure and the owner specifies and temperature higher than 120°F for this test, the pressure must be reduced to the maximum allowable working pressure and the temperature to 120°F for close examination.

Finally, the inspector will review the boiler log and the records of maintenance and feedwater treatment to determine what regular tests have been made on the boiler and controls. He will consult the owner or user regarding any repairs made since the last inspection and will review such repairs for compliance with Chapter III of the National Board Inspection Code.

The inspector will discuss any defects or deficiencies in the condition or the operating and maintenance practices of the boiler and auxiliary equipment with the owner or user at this time and recommend any necessary corrective actions.

A National Board commissioned inspector is a well trained, experienced individual, who may be in the employ of your insurance carrier, a state of the U.S. or a province or Canada, or a large municipality. He offers you an independent evaluation of your boiler's physical condition. He will recommend only repairs or maintenance necessary to safeguard the integrity of your boiler. His prime interest is public safety. Listen to him and follow his advice.

GLOSSARY

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Boiler: A closed vessel intended for generating steam or other fluids (to be used externally to itself), under pressure or vacuum, by the direct application of heat from combustible fuels, electricity or nuclear energy.

Boiler Auxiliary: Any equipment of the feedwater system and combustion air and fuel systems. This shall include feedwater pumps, feedwater heaters, and deaerators, evaporators, economizers, condensate receivers, fans, combustion air and fuel oil preheater, fuel oil pumps, coal feeders, conveyers, hoppers, bins, pulverizers, dryers, and ash collection and removal equipment.

Code: The Boiler and Pressure Vessel Code of the American Society of Mechanical Engineers with such revisions, amendments and interpretations thereof as are made and approved and adopted by the Council of the Society. Copies of the Code maybe obtained from the Society at 29 West 39th Street, New York City, N.Y.

Condemned Boiler or Unfired Pressure Vessel A boiler or unfired pressure vessel that has been inspected and declared unsafe, or disqualified by an inspector qualified to take such action who has applied a stamping or marking designating its rejection,

Design Pressure: The maximum allowable working pressure at the time the boiler or unfired pressure vessel was built.

Domestic Hot Water Heater: A closed vessel which generates hot water of less than 210°F.

External Inspection: An inspection made of the external parts of a boiler or unfired pressure vessel under pressure, its appurtenances, and connections as specified by this manual.

Firing Equipment: Any equipment provided to inject, move or support fuel in the boiler furnace. This includes all burners, gas burners, fuel injectors, fuel igniters, coal stokers and feeders, grates, and over-fire steam or air jets.

Fusion Welding: A process of welding metals in a molten, or molten and vaporous state, without the application of mechanical pressure or blows.

Such welding may be accomplished by the oxyacetylene or oxyhydrogen flame or the electric arc. Thermit welding is also classed as fusion welding.

Heat Exchanger: unfired vessel used to transfer heat from one medium to another.

Heating Boiler: A steam boiler operated at pressures not exceeding 15 psig or a low temperature hot water boiler.

High Pressure: A closed vessel in which steam or other vapor (to be used externally to itself) is generated at a pressure of more than 300 psig.

High Temperature: A fired heat exchanger which heats water to a temperature in excess of 250°F at a pressure above 160 psig.

High Temperature Water Heat Exchanger: An unfired water to water heat exchanger used to transfer heat from the primary high temperature hot water supply to a secondary loop.

Hydrostatic Test: The application of a pressure by means of water or other liquid to the various pressure parts of a boiler or unfired pressure vessel.

Hyperbaric Facility Support Pressure Vessels: Hyperbaric facility support pressure vessels are unfired pressure vessels used to contain fluids. They include gas storage flasks volume tanks, fire water tanks, and filters with a cross sectional internal dimension in excess of 3 inches. Hyperbaric facility pressure vessels which are intended to be occupied by personnel, animals or test equipment during pressurization are specifically excluded from this definition.

Installed Working Pressure: The pressure on the gage, at which the boiler or unfired pressure vessel is normally operated. Synonymous with operating pressure.

Internal Inspection: An inspection made when a boiler or unfired pressure vessel is shut down and handholes, manholes, or other inspection openings are opened for inspection of the fire, gas, air and water sides as specified by this manual.

Low Temperature Water (LTW) Boiler: A fired heat exchanger which heats water to a temperature below 250 degrees F at a pressure below 160 psig.

LPG (liquid propane gas) Tank: A tank used to store LPG.

Major Repair: A repair upon which the strength of a boiler or unfired pressure vessel depends.

Maximum allowable working Pressure: The pressure indicated as such on the name-plate of a boiler or that determined by employing the factors of safety, stresses, and dimensions designated in the ASME code, whichever is lower. The term, maximum allowable working pressure, at the coincident metal temperature, permissible at the bottom of the vessel in its operating position and which is the basis for the upper limit in pressure setting of the safety relieving devices for any specific operation.

Nonstandard Boiler or unfired Pressure Vessel: A boiler or unfired pressure vessel that does not bear the ASME stamp or the stamp of the National Board of Boiler and Pressure Vessel Inspectors.

Operating Pressure: The actual pressure at which the boiler or unfired pressure vessel operates. Synonymous with the term "installed working pressure".

Pneumatic Test: The application of pressure by means of air or other gases to the various parts of an unfired pressure vessel.

Portable Boiler: An internally fired boiler which is primarily intended for temporary location and the construction and usage of which is obviously portable. This category includes Navy "Mobile Utilities Support Equipment" (MUSE) boilers.

Power Boiler: A closed vessel in which steam or other vapor (to be used externally to itself,) is generated at a pressure of more than 15 psig but not more than 300 psig by the direct application of heat.

Psig: Pounds per square inch gage.

Reinstalled Boiler or Unfired Pressure Vessel: A boiler or unfired pressure vessel removed from its original setting and re-erected at the same

location or erected at a new location without change of ownership.

Residential or Commercial Warm Air Furnace: A direct fired heat exchanger which is used to heat air for residential and commercial heating applications.

Safety appliances: Any device providing protection for boiler or unfired pressure vessel against excess pressure of steam, vapor, air, water, or other liquid. This includes steam safety valves, fusible plugs, air, water or other liquid pressure relief valves, combination pressure-temperature relief valves and rupture disks.

Second Hand Boiler or Unfired Pressure Vessel: A boiler or untired pressure vessel of which both the location and ownership have been changed after primary use.

Standard Boiler or Unfired Pressure Vessels: A boiler or unfired pressure vessel which bears the ASME stamp, or the stamp of the NBBI.

Unfired Pressure Vessel: A closed vessel in which internal pressure is above or below atmospheric pressure, and pressure is obtained from an external source or from an indirect application of heat.

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